

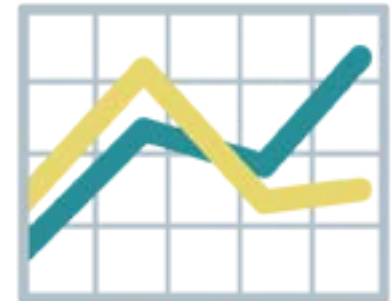
Flood Damage and Life Risk Analysis

Risk and Economics Analysis Session

Technical Workshop #2:

**Tools and Data for Measuring Progress Toward
Achieving the Basin-Wide Feasibility Studies
and Central Valley Flood System Conservation
Strategy Objectives**

October 24, 2013



PUBLIC SAFETY

ENVIRONMENTAL STEWARDSHIP

ECONOMIC STABILITY

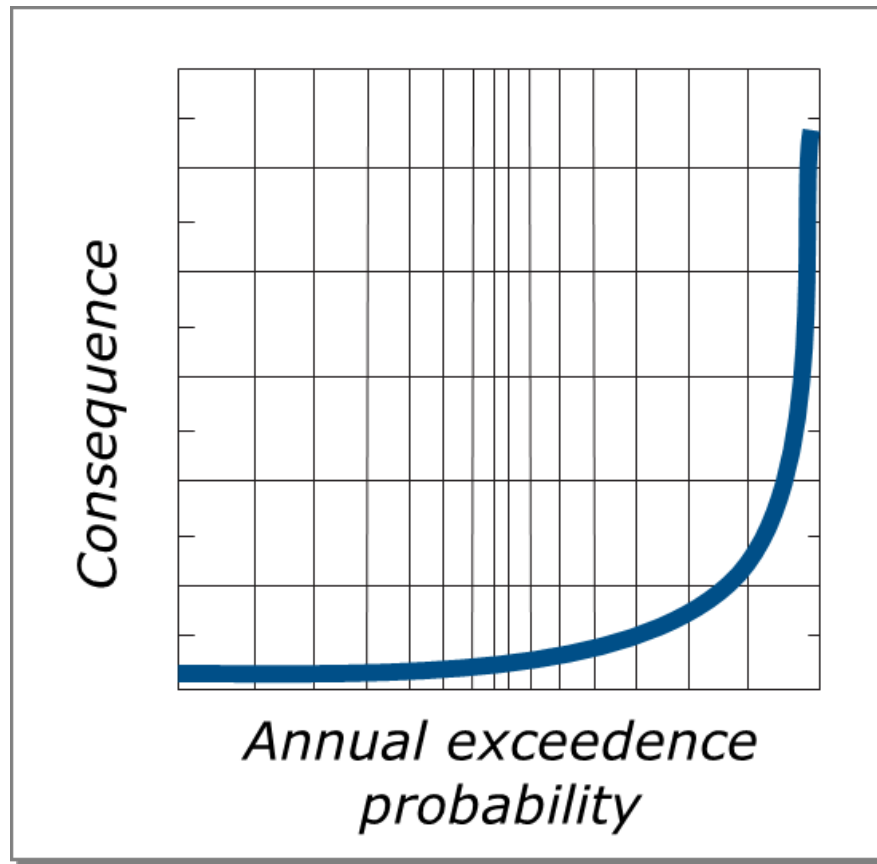


San Joaquin BWFS Planner
By Day...

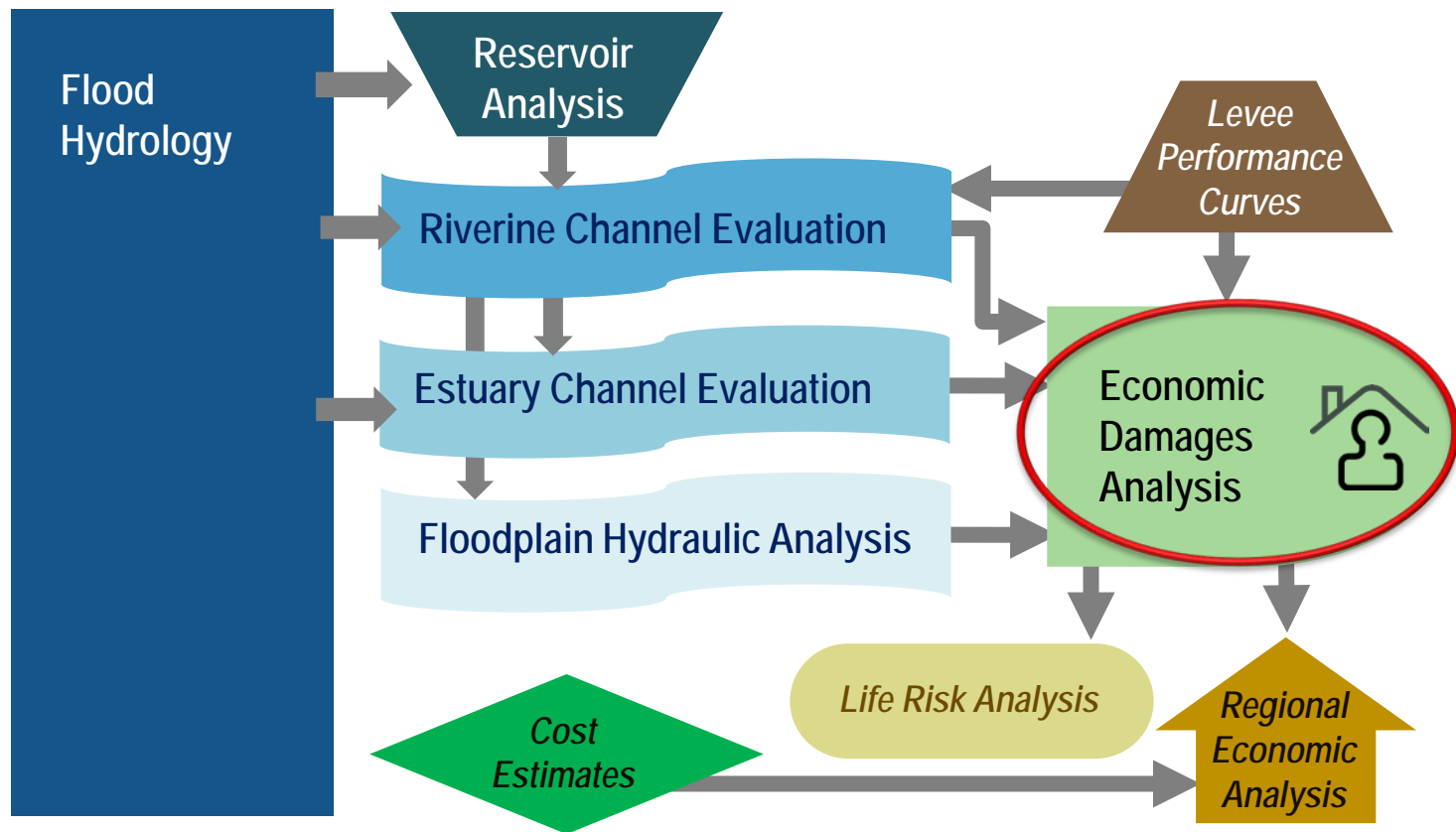


...HEC-FDA Modeling
Superhero in his dreams

Flood Risk



Systemwide Analysis Tools & Data



Purpose of Flood Damage Analysis

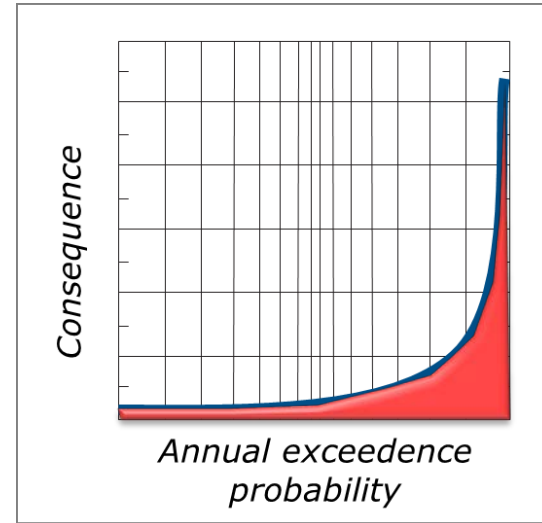
- Estimate potential tangible flood damages to determine flood risk reduction:
 - Structures
 - Contents
 - Crops
 - Business losses

Attachment 8F
Flood Damage Analysis

Flood Damage Analysis Outputs

- Expected Annual Damages (EAD)

- Annualized damages from periodic flooding



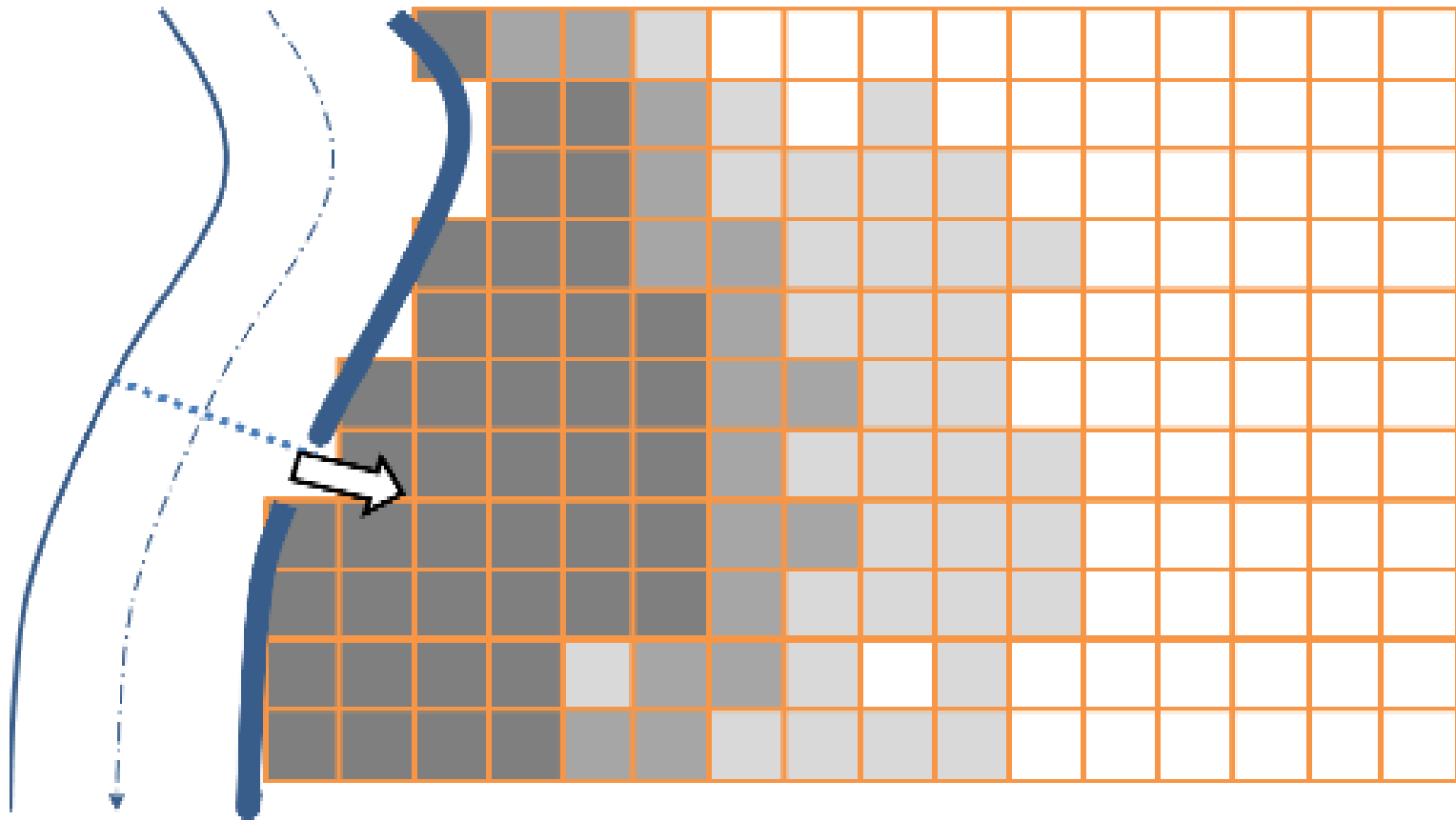
- Annual Exceedence Probability (AEP)

- Likelihood of being flooded in a given year

Link to Objectives and Metrics

Objective	Metric
People and Property at Risk	Annual probability of flooding
	Damages to property, crops, and infrastructure
	Number of small communities with 100-year level of protection
Flood System Flexibility	Ability to achieve the above under alternative future conditions
Flood System Resiliency	Reductions in economic damages with added resiliency measures in place
Consistent and Efficient O&M Practices	Improved system performance or reliability

HEC-FDA Conceptual Framework



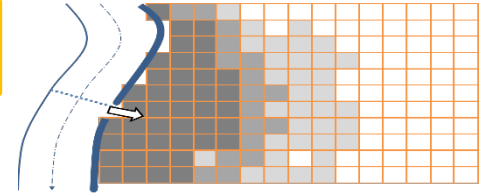
HEC-FDA Inputs and Outputs

Economic inventory

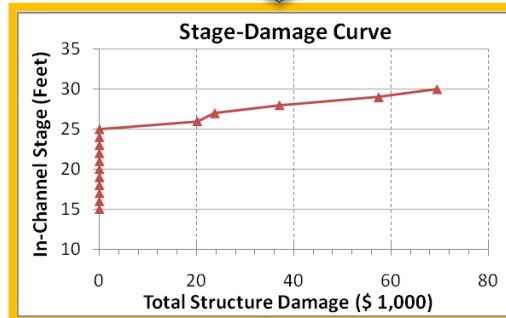
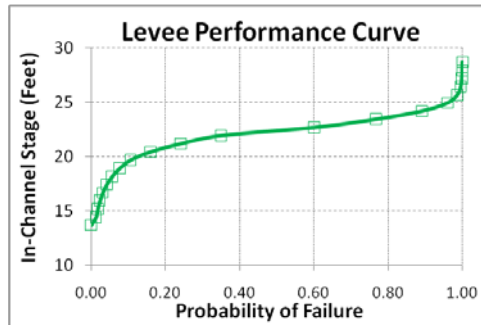
- Structure data
- Crop data
- Damage assumptions

Floodplain

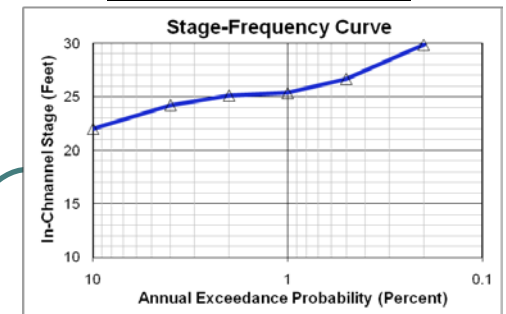
- depth grid



Levee Evaluations



Hydraulic Results

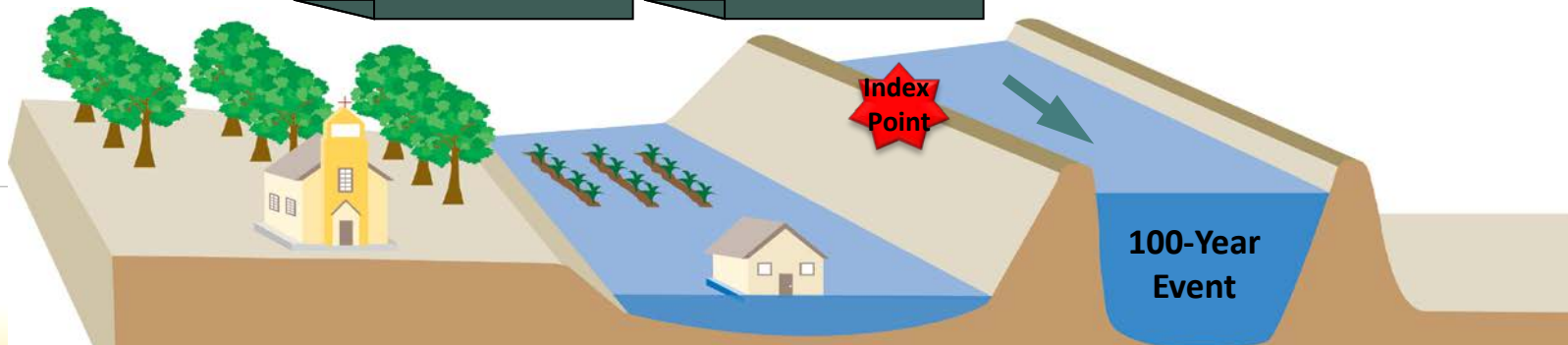


HEC-FDA
Monte Carlo
analysis

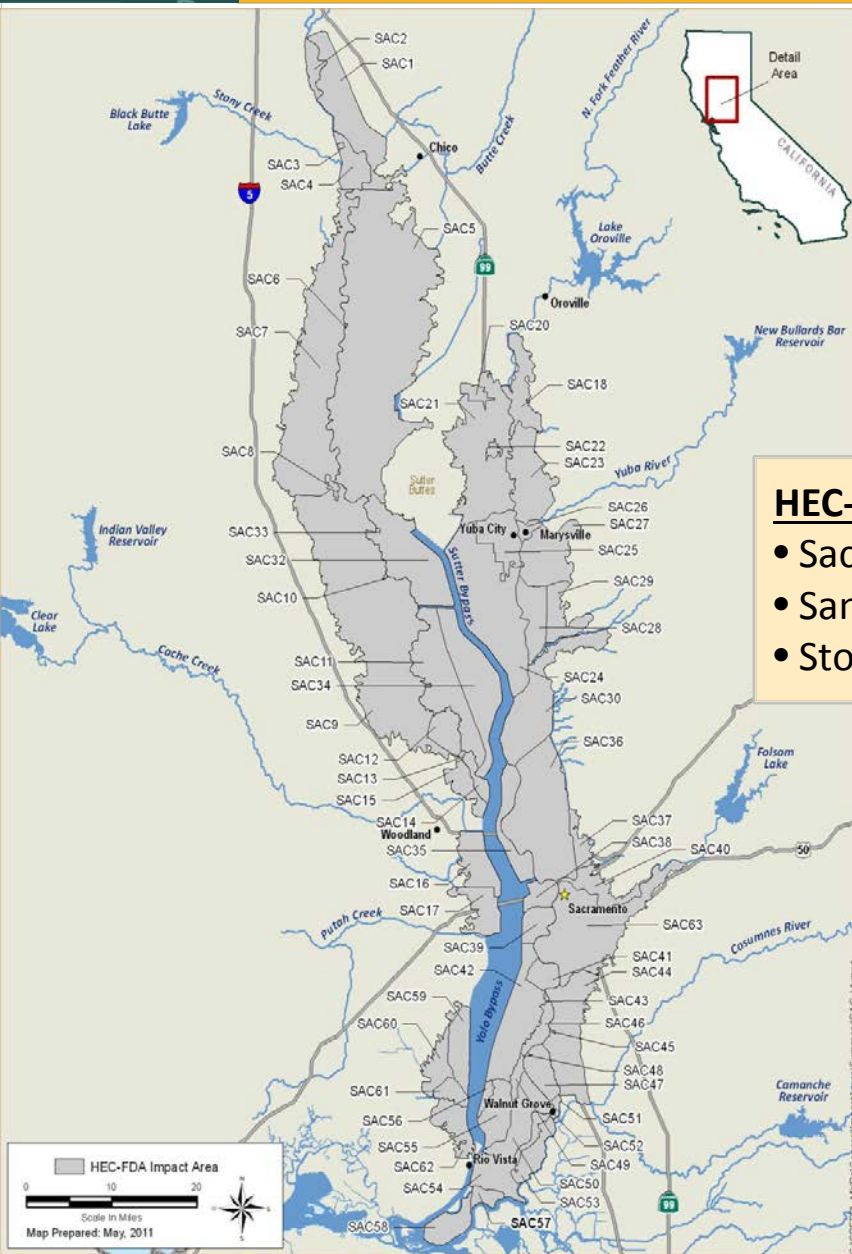
Input data
uncertainties

Expected Annual
Damage (EAD)

Annual Exceedance
Probability (AEP)

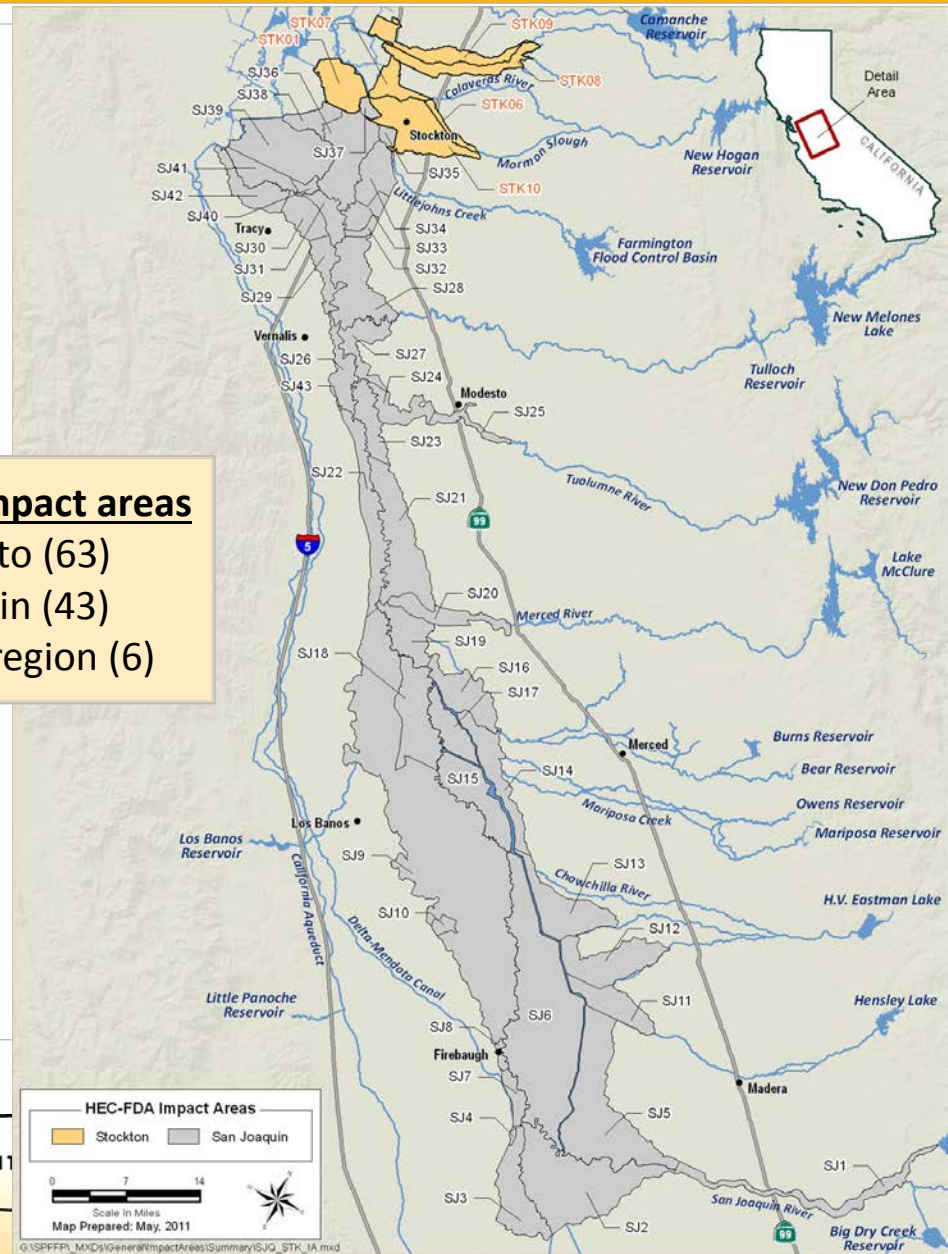


CVFPP HEC-FDA Impact Areas



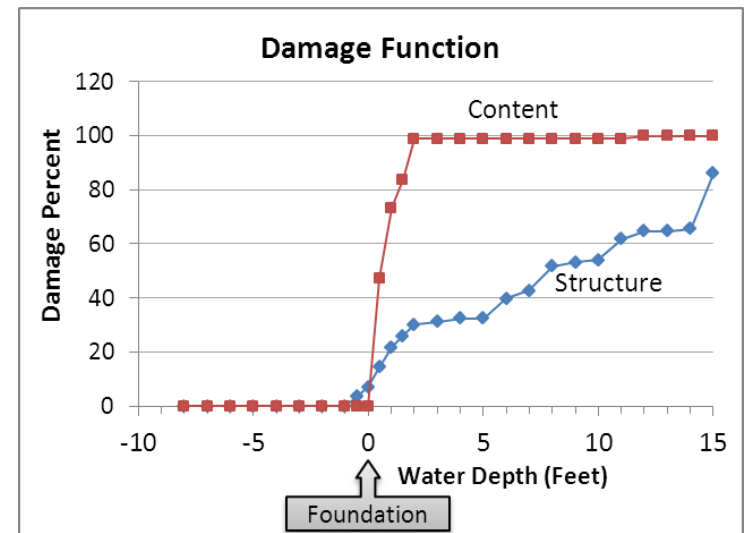
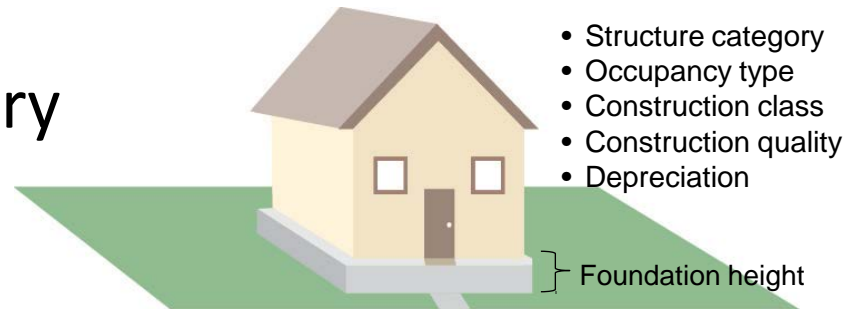
HEC-FDA impact areas

- Sacramento (63)
- San Joaquin (43)
- Stockton region (6)



HEC-FDA Inputs: 2010 Structure Inventory

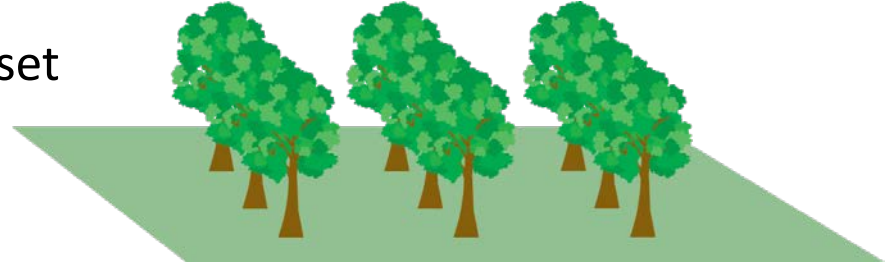
- Update the structure inventory from the Comp Study
- Parcel data: 2010 June ParcelQuest
- Updates: reconnaissance-level field surveys
- Estimated value: structural characteristics



HEC-FDA Inputs: Crop and Business Losses

Crop

- Acreage: 2010 DWR GIS landuse dataset
- 117 DWR agricultural land uses -> 20 crops
- Data preprocessed in Crop Damage Spreadsheet



Business Losses

- Estimate economic output per day for non-residential structures
- Estimate temporary business interruption days

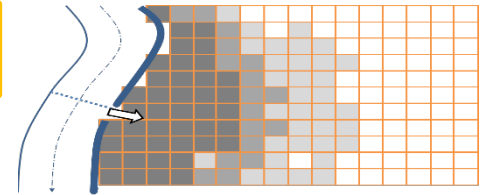
Overview of HEC-FDA Modeling

Economic inventory

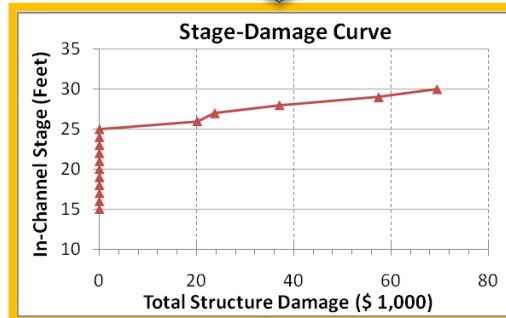
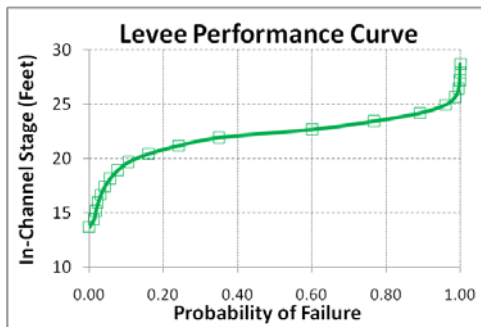
- Structure data
- Crop data
- Damage assumptions

Floodplain

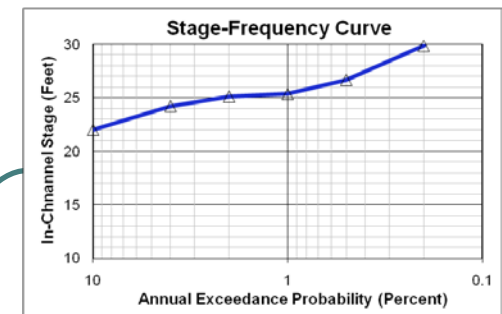
- depth grid



Levee Evaluations



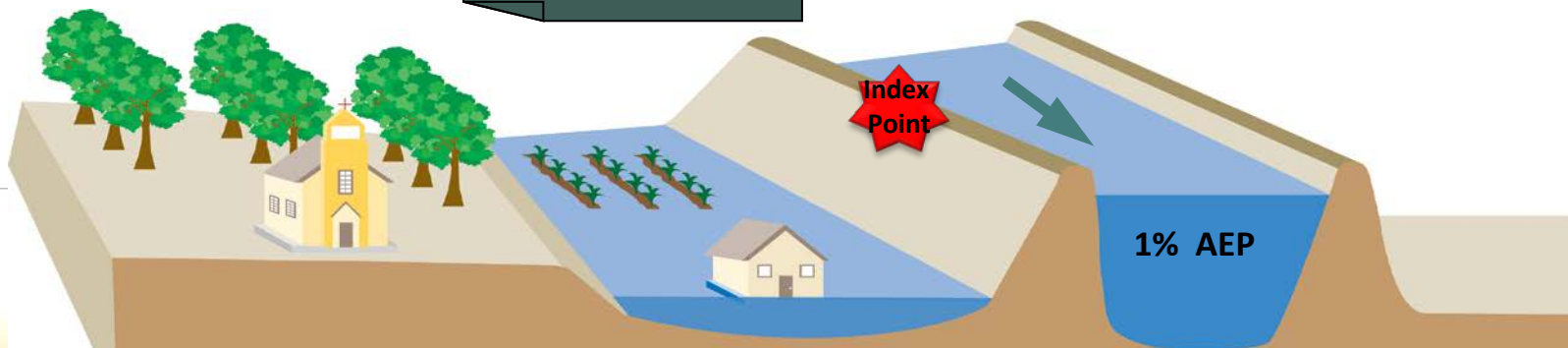
Hydraulic results



HEC-FDA
Monte Carlo
analysis

Input data
uncertainties

Expected Annual
Damage (EAD)

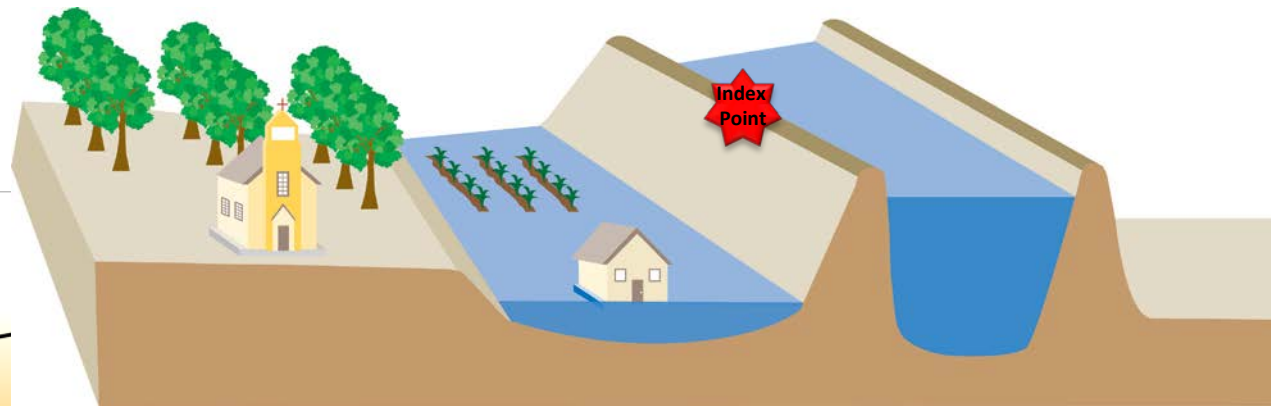
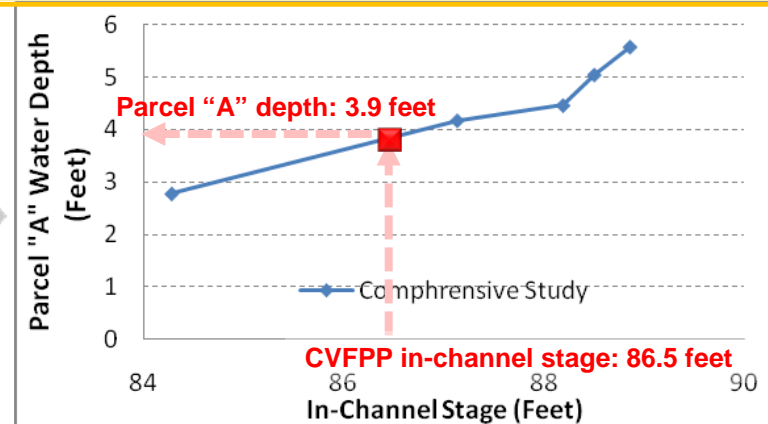
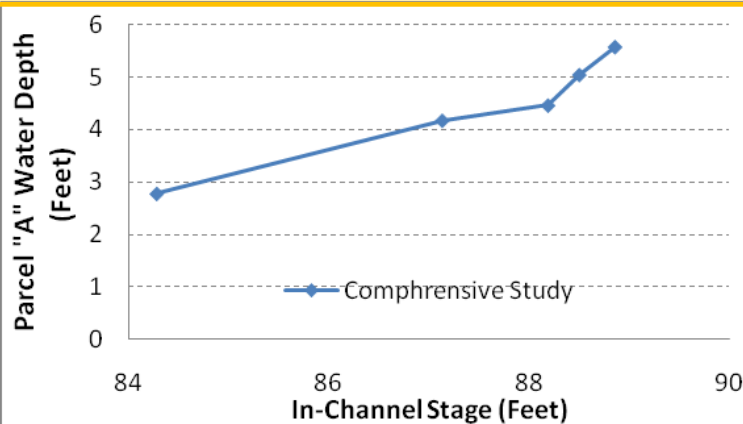


HEC-FDA Inputs: Floodplain Depth Grid

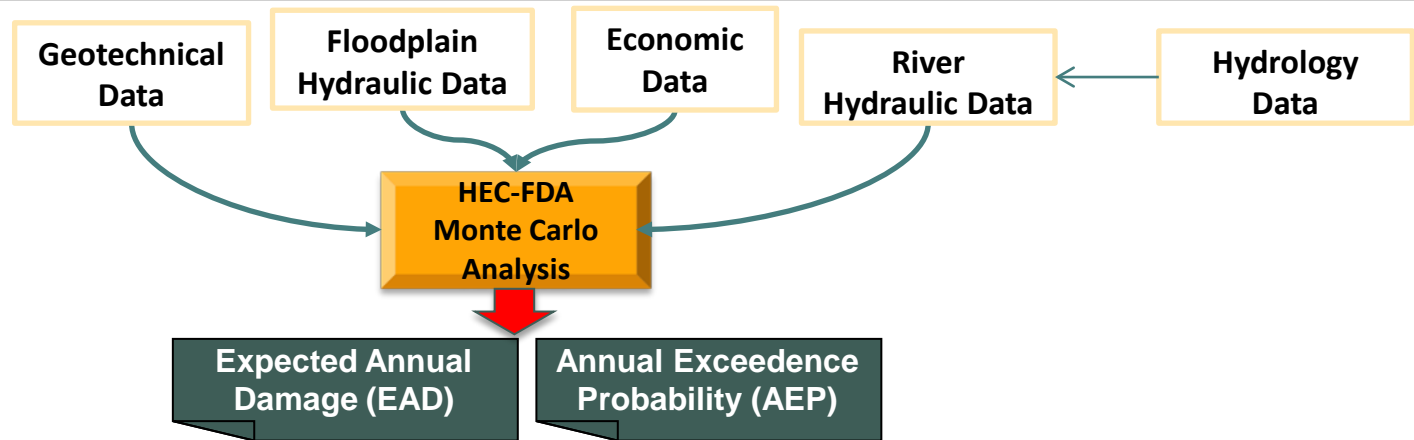
- **Source #1:** Floodplain model (RMA Delta Model/FLO-2D)
- **Source #2:** Derived from Comp Study FLO-2D depth grid

Key Assumption:

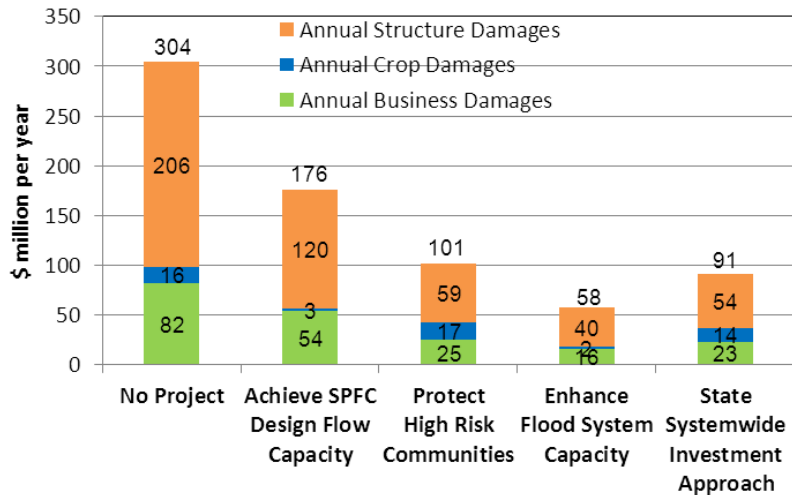
Depth of flooding in each impact area is directly related to river stage at a single index point.



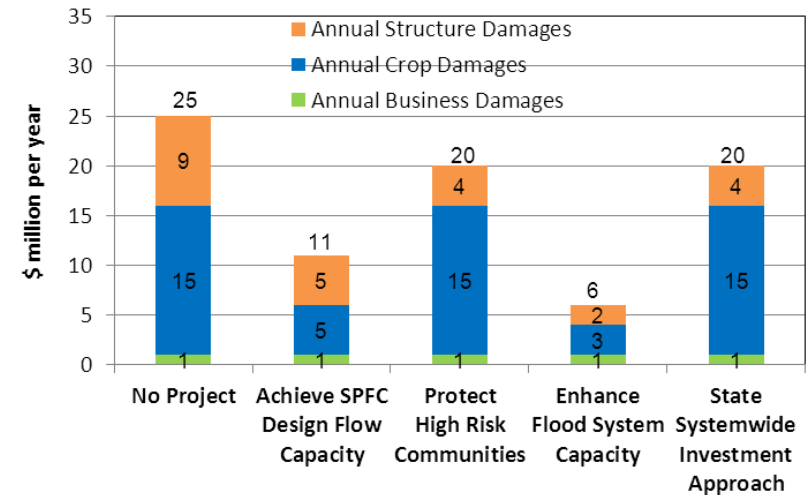
Flood Damage Evaluation: Results



Sacramento River Basin Expected Annual Damages



San Joaquin River Basin Expected Annual Damages



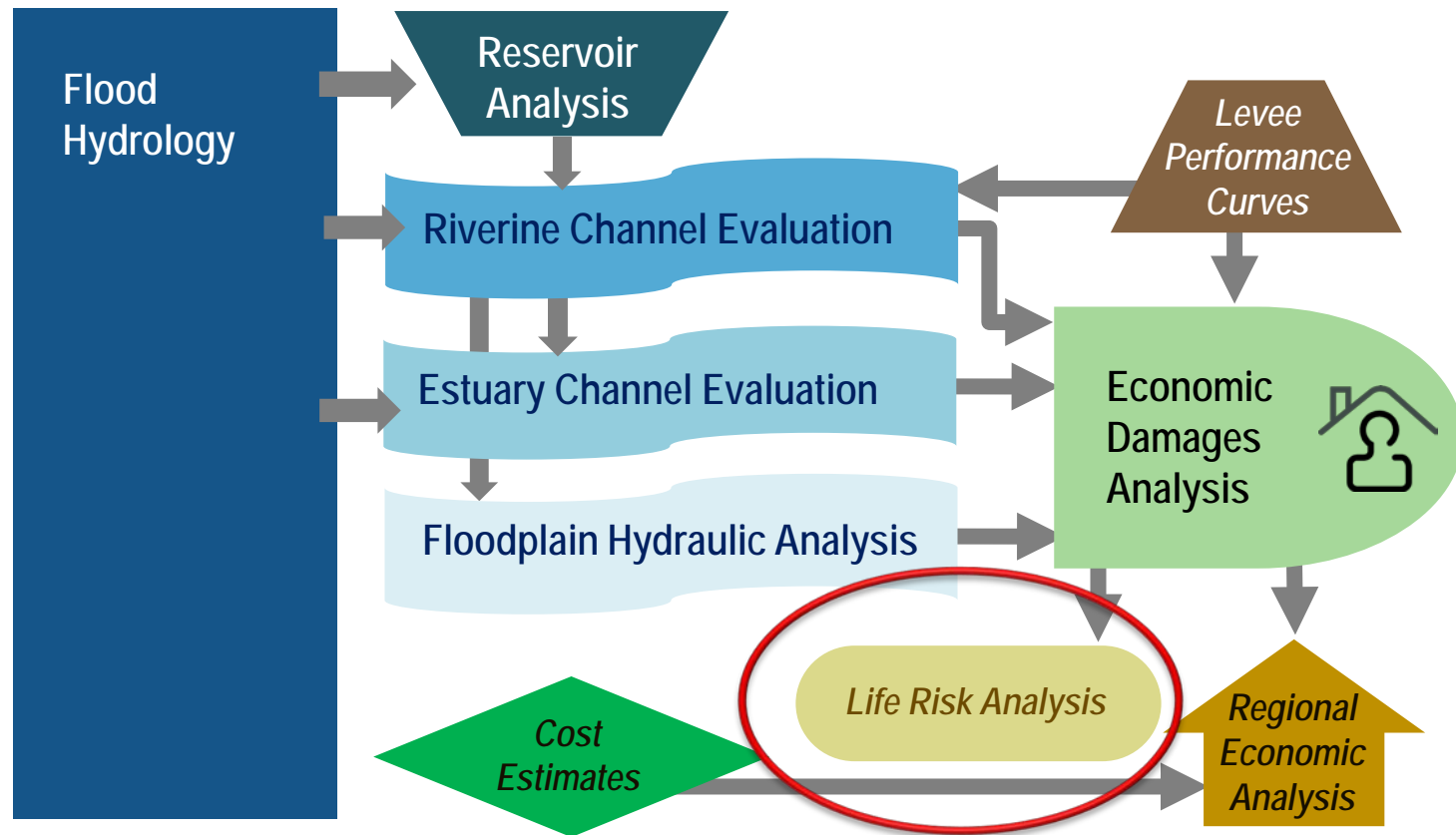
Flood Damage Analysis Enhancements

- Will apply new hydrology (CVHS) and hydraulics (CVFED) models
- Updated the 2010 structure inventory, focusing on high value properties
- Incorporated considerations of other tangible flood damage categories:
 - ✓ Vehicles damages
 - ✓ Roads damages
 - ✓ Post-disaster emergency and recovery costs

Flood Damage Analysis

Questions?

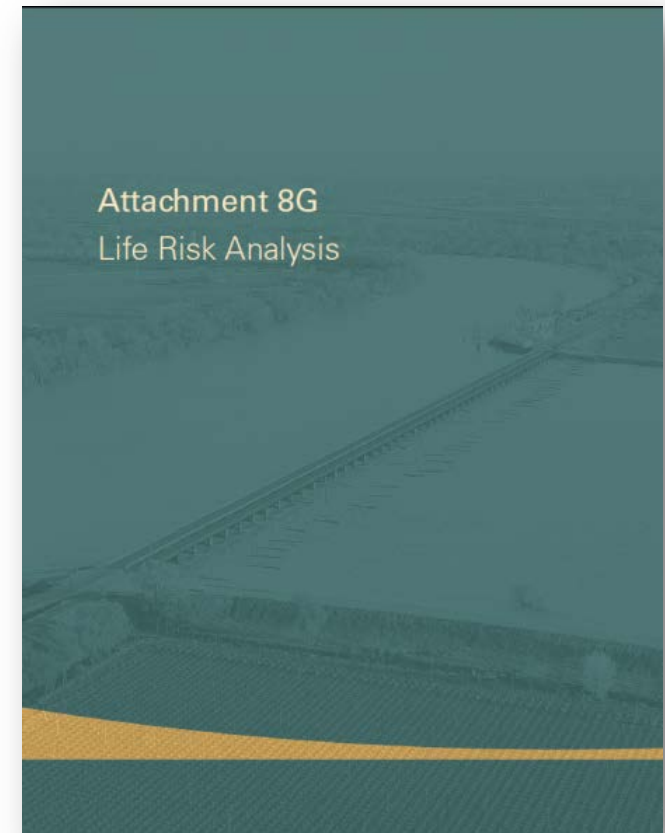
Systemwide Analysis Tools & Data



Life Risk

Needed a method that:

- Systematic, reproducible, and defensible
- Based on reasonable science
- Relies on empirical data
- Relies on readily available data
- Applicable systemwide



Link to Objectives and Metrics

Objective	Metric
People and Property at Risk	Risk to human life, health, and safety
Flood System Flexibility	Ability to achieve the above under alternative future conditions

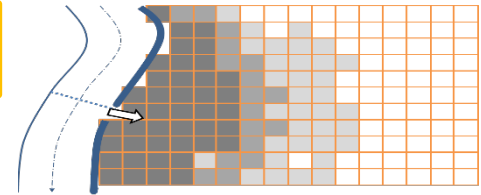
HEC-FDA Inputs and Outputs

Economic inventory

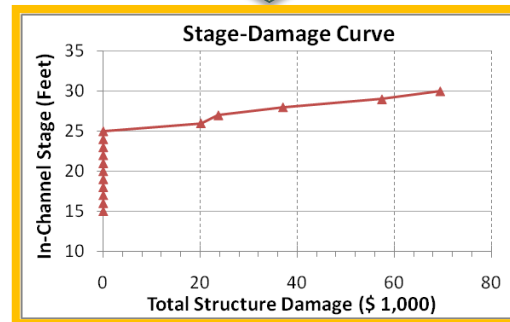
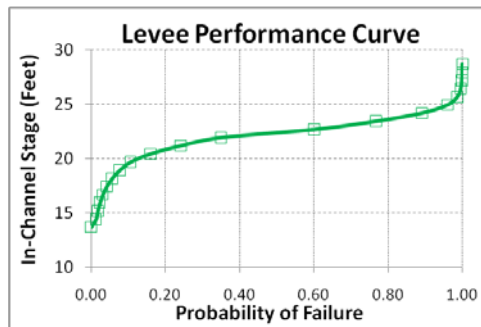
- Structure data
- Crop data
- Damage assumptions

Floodplain

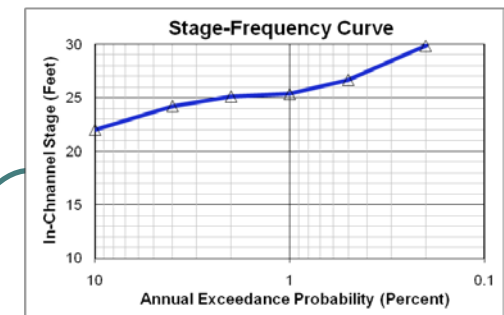
- depth grid



Levee Evaluations



Hydraulic results

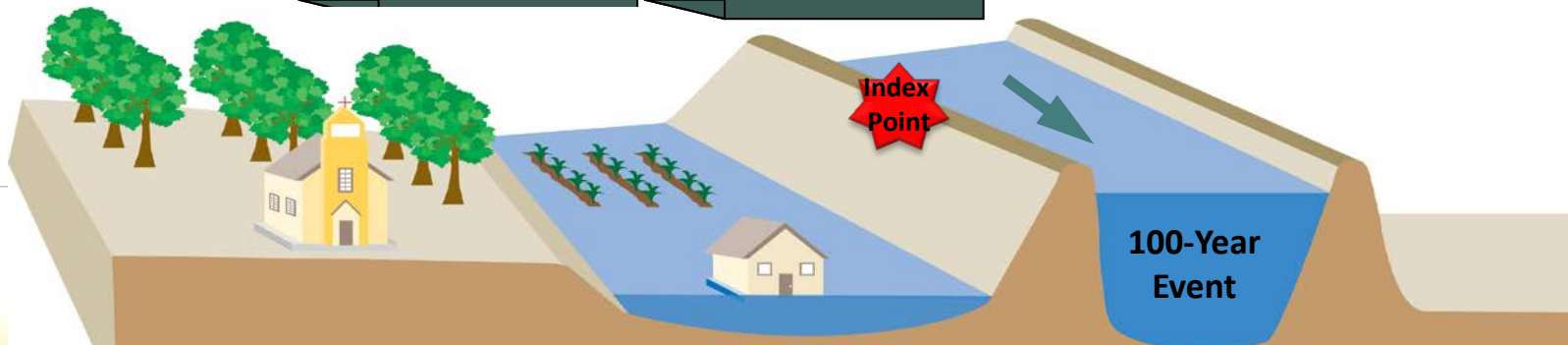


HEC-FDA
Monte Carlo
analysis

Input data
uncertainties

Expected Annual
Damage (EAD)

Annual Exceedance
Probability (AEP)



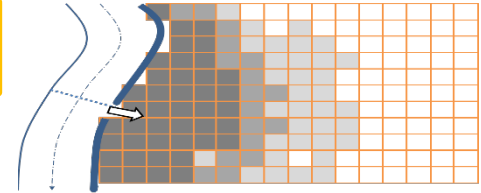
HEC-FDA Inputs and Outputs

Inventory

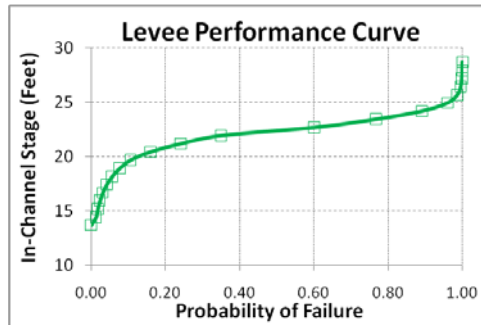
- Population at Risk

Floodplain

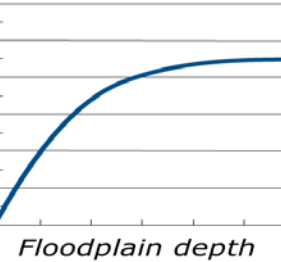
- depth grid



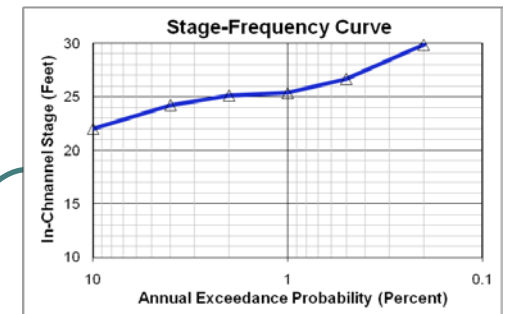
Levee Evaluations



Potential Mortality



Hydraulic results

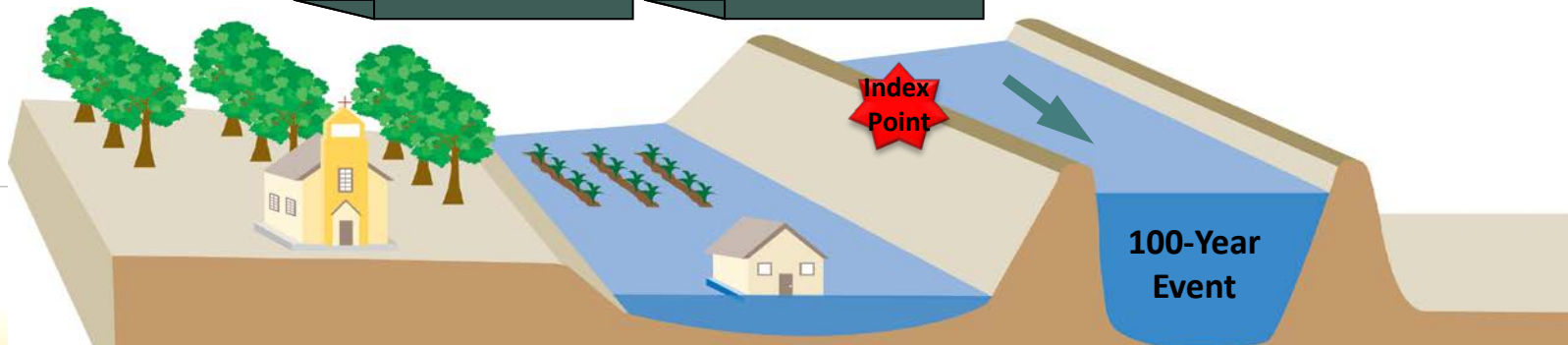


HEC-FDA
Monte Carlo
analysis

Input data
uncertainties

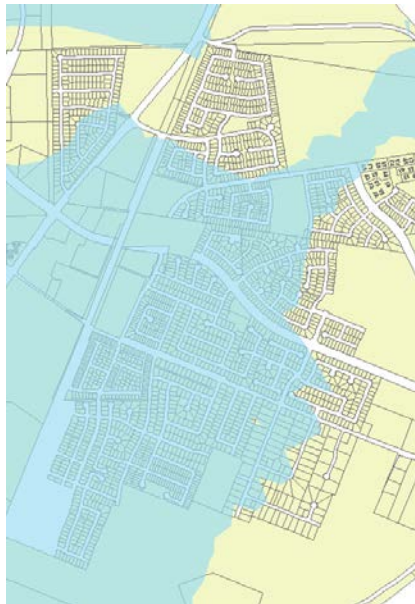
Expected Annual
Life Loss

Annual Exceedance
Probability (AEP)

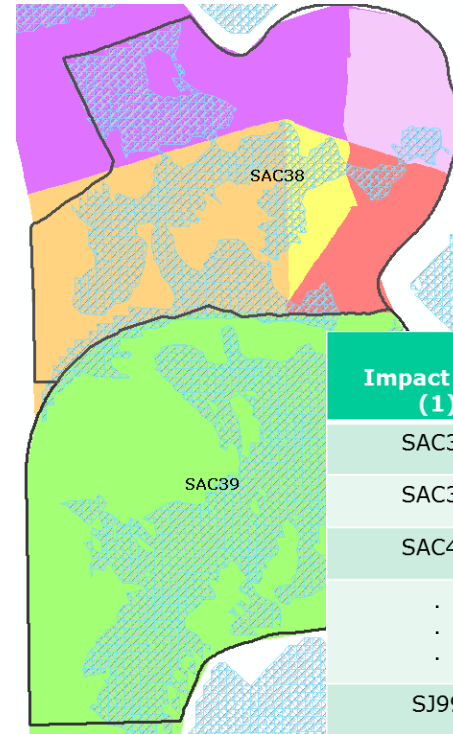


Exposure

- Replaced structure value with population



Parcel ID (1)	Value of property (\$1,000) (2)
046-491-005-000	165.83
046-491-004-000	150.97
046-492-008-000	217.21
.	.
.	.
.	.



Impact area (1)	Population in floodplain (2)
SAC38	91644
SAC39	789797
SAC40	7217
.	.
.	.
SJ99	12565

- Estimated number of people for each structure in each impact area using 2000 Census Data

Exposure

- Accounted for evacuation using warning system performance

Warning system performance

Warning time

Warning time

The time available for residents to take action to protect themselves and their property after a public flood warning has been issued.

Fraction of the public that receives a warning

Sorensen and Mileti (1988) developed equations to estimate the fraction of public warned (F_{rw}) based on warning time.

Fraction of the public willing to respond to a flood warning

As part of the EFREP portion of the Comp Study, DWR completed an expert elicitation to estimate F_w .

Fraction of the public capable to respond to a flood warning

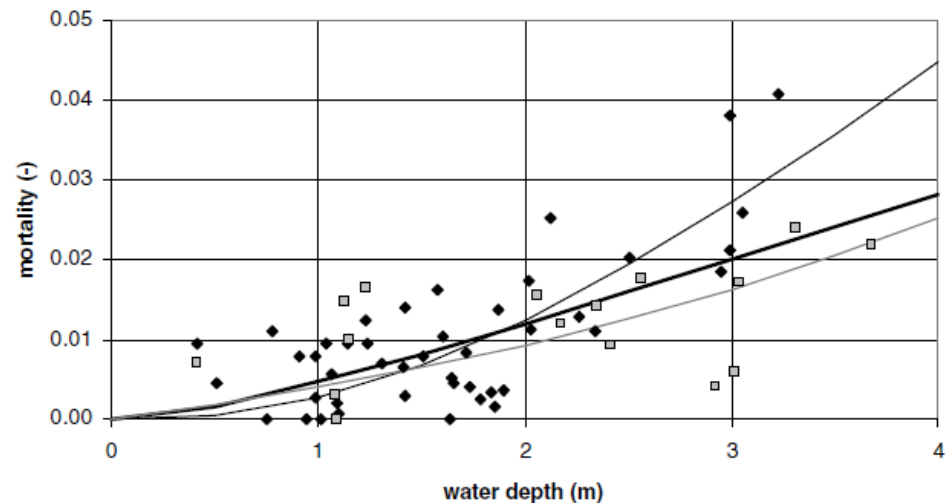
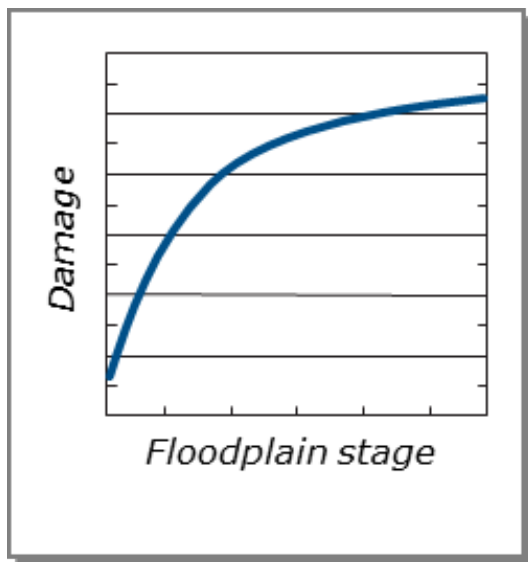
As part of the EFREP portion of the Comp Study, DWR completed an expert elicitation to estimate F_c .

warning system efficiency

A measure of warning system performance
 $eff = F_{rw} * F_w * F_c$

Vulnerability

- Replaced depth-damage function with depth-%mortality function



Jonkman (2009)

A screenshot of the 'CVFPP - Study Structure Occupancy Types' dialog box. The 'Damage Category' is set to 'Residential'. The 'Structure Occupancy Type' is 'RES-LDL'. The 'Description' is 'Depth-%mortality relationship from Jonkman 2009'. The 'Define Depth-Percent Damage Function' section has 'Structure...' checked. The 'Content to Structure Value Ratio (percent)' is 0.000. The 'Define Uncertainty Parameters' section has 'First Floor Stage...' and 'Structure Value...' checked.

Potential Life Risk Analysis Enhancements

- Update depth-% mortality functions
 - Use age thresholds for ability to evacuate
 - Consider horizontal and vertical evacuation
- Update US Census information
- Update flood warning times (for evacuation estimates)
- Consider time of day that flooding occurs
- Use updated flood hydrology and hydraulics models

Life Risk Analysis

Questions?